CORRESPONDENCE

COMMENTS ON "EVIDENCE FOR INERTIAL OSCILLATIONS ALONG TRANSOSONDE TRAJECTORIES"

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It has occurred to me that a more descriptive title for Dr. Angell's [1] paper might have been *A Lack of* Evidence for Inertial Oscillations Along Transosonde Trajectories." The italicized words are my proposed addition to the title. Since one expects to find atmospheric motions with all periods, a "discovery" of a definite periodicity in the velocity fluctuations implies that fluctuations with this frequency have greater amplitude than those of nearby frequencies. This kind of verification was absent in Dr. Angell's own statistical analysis in an earlier paper [2]. The present evidence consists of data passed through a filter which effectively removes oscillations with a period less than 12 hours so that the high-frequency portion of the spectrum is not available for application of this criterion.

I would agree with Dr. Angell's statement that inertial oscillations can be observed in "carefully screened transosonde data," but it is my contention that the most surprising and significant result of the constant-altitude balloon trajectories is the relatively small amplitude of oscillations at the inertial period. Indeed, since theory [1] leads one to expect enhancement at these frequencies, the difficulty in observing the inertial oscillations can only be interpreted as evidence for a critical damping of these frequencies.

REFERENCES

1. J. K. Angell, "Evidence for Inertial Oscillations Along Transosonde Trajectories," *Monthly Weather Review*, vol. 90, No. 5, May 1962, pp. 186–190.
2. J. K. Angell, "An Analysis of Routine 300-mb. Transosonde Flights from Japan," *Monthly Weather Review*, vol. 86, No. 9, Sept. 1958, pp. 335–343 (p. 341).

[1] "Theory" has numerous sources including the numerical integration of exact particle trajectories, but it can be expressed quite simply in the terminology of automatic controls. One component of equations of motion for horizontal flow may be written:

$$\ddot{v}+f^2v=F(x,y,t)$$

where the function F depends on the appropriate component of the forces and the remaining symbols have their usual meteorological connotation. If the term on the right is considered a forcing function, the velocity has a transfer function $1/(f^2-\omega^2)$, and one expects larger amplitudes at the inertial period compared with other frequencies unless there is some feedback with the function F.

REPLY

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I tend to share Professor Mantis' surprise at the small amplitude of inertial oscillations and the difficulty of their detection. It is for this reason that it appeared worthwhile to show that evidence for such oscillations is to be obtained from Lagrangian data, particularly since no really convincing evidence for inertial oscillations has come from Eulerian data despite the work of Newton [1], Sawyer [2], and others. It is believed that figure 2 in the article under discussion represents as good statistical evidence as has yet been presented for the existence of inertial oscillations, and this figure seems incompatible with the change in title suggested by Professor Mantis.

The technique applied in the article was simply to determine the frequency of occurrence of oscillations of different period and, in contrast to spectral analysis, the amplitude of the oscillation was irrelevant as long as it exceeded the arbitrary 10-kt. limit. This is hardly desirable, but such a technique was dictated by the analysis of transosonde flight 993 ([3], p. 195), where oscillations of inertial character were scarcely detectable in the spectral analysis due to variability of the inertial period occasioned by change in latitude and relative geostrophic vorticity along the trajectory. Thus it is not too surprising that in Mantis' reference [2], an article based on only a few months of transosonde data, spectral analysis did not point up inertial or near-inertial periodicities. It might be noted, however, that a subsequent spectral analysis of unsmoothed 2-hour-average velocities derived from 2 years of FCC-positioned transosonde flights showed that spectral peaks occurred most frequently at a period of oscillation of 11 hours ([3], p. 196). This is in good agreement with the results presented in the article under discussion and suggests that the smoothing of the positions has not seriously influenced the analysis. Along this line, my smoothing technique reduces the amplitude of 8-hour velocity periodicities by 50 percent so that the filter cut-off seems more logically put at 8 hours than 12 hours. Nevertheless, it is true that the situation at the high

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